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An Evaluation of Blood Cultures in the Emergency Centre

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Dissertation submitted as partial fulfilment of criteria for the degree: Master of
Philosophy in Emergency Medicine for the University of Cape Town: Faculty of Health
Sciences

I declare that this dissertation is my own unaided work. It is being submitted for Part III of the degree of Master of Philosophy (Emergency Medicine) to the Faculty of Health Sciences, University of Cape Town. It has not been submitted before for any degree or examination at any other university. The work is entirely my own and was researched and written up independently with the oversight of research advisors.

Signed this ____ day of _____ 2011 in _____.

Dr Julian Fleming

University of Cape Town

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Part A: Research Protocol

INTRODUCTION AND LITERATURE REVIEW

Emergency Centres (ECs) are most often the first point of contact for patients who present with acute febrile illnesses, who may or may not require hospital admission. Anecdotally, while some ECs have protocols for which of these patients require blood cultures, most do not - often the deciding factors for which patients have blood cultures taken are admission to an inpatient team or the personal preference of the treating physician.

Most ECs in South Africa are under pressure from a high patient load and low staff complement. With blood cultures being costly, taking longer than usual blood tests to obtain, requiring specific methods of collection and offering no immediate diagnostic assistance, their value to a busy EC is questioned. A significant number of patients may also be discharged prior to the results becoming available, which negates any value of the test in the first place.

Internationally, Blood Cultures done in ECs are positive for bacterial growth in up to 20% of patients cultured^{1, 2}. Bacteraemia, however, affects only up to 1.4% of patients, implying that there is significant contamination rates in blood cultures done in the EC^{1, 2}.

Whilst hospitalized patients have up to a 10 fold increase in bacteraemia when compared to all EC patients cultured², studies have shown as few as 0.18% patients cultured in the EC had their management influenced by these positive results¹.

In patients with pneumonia who are cultured and subsequently admitted into hospital, empiric antibiotics as per local protocols, are started before the results of cultures are known, and these antibiotics are rarely, if ever, modified once the results become available^{3, 4}. Changing the antibiotics to a narrower spectrum is usually not done after results are obtained⁴, and when they are, the cost savings to the hospital are usually minimal in any case³.

Multiple causes of high contamination rates exist, including withdrawing blood from IV cannulae as opposed to dedicated venepuncture⁵, and both aerobic and anaerobic bottles are usually obtained where this may be inappropriate in the clinical setting⁶.

Analysis of Blood Cultures in a South African context may provide information and clarity on modifying current practice to make the care and investigation of the febrile patient presenting to the EC more cost effective and clinically appropriate.

AIM

The aim of this study is to determine whether routine blood cultures performed in a secondary level hospital Emergency Centre affect the choice of antibiotic used in treating patients with bacterial infections.

A secondary aim is to determine if staff in the EC are aware of correct procedures for drawing blood cultures, and whether their practice reflects this.

STUDY METHODS

This will be a retrospective analysis of all blood cultures done in GF Jooste hospital over a 12 month period (1 April 2008 – 31 March 2009). The EC sees approximately 45 000 patients per year, and approximately 300 blood cultures are performed every month.

The clinical records of all patients in whom a blood culture has been performed, and who fit the inclusion criteria will be reviewed. The following data will be collected and collated:

- Date of admission to EC
- Date of first blood culture
- EC diagnosis including HIV status and CD4 count (if known)
- Admission date to specialty
- Discharge date from specialty
- Result date of blood culture
- Result of blood culture (including contaminated result)
- Documented change in antimicrobial therapy in line with the blood culture result

Inclusion Criteria:

- Age 18 or greater
- Blood culture performed by EC staff in EC
- Recorded blood culture result by laboratory

Exclusion Criteria

- Age < 18
- Blood culture done by non EC staff or on ward
- No final blood culture result available
- Patient transferred to another facility before blood culture result available

The data will be analysed and presented as simple descriptive statistics.

- The percentage of positive blood cultures overall and in certain diagnostic groups e.g. HIV positive, pneumonia.
- The likely contaminant rate as determined by species and colony size.
- The percentage of cases where culture results changed management.

Secondly, a short questionnaire regarding blood culture collection techniques will be given to Emergency Centre medical staff at GF Jooste Hospital. The data from this questionnaire will be analysed and presented as descriptive statistics presenting individual answers as well as overall rate of technique and contamination risk.

ETHICS

This study will be presented to the Research Ethics Committee of the Faculty of Health Sciences UCT for approval.

Only patient records from GF Jooste Hospital Emergency Centre will be used in this study. No patient names or other methods of identifying the patients involved will be used in the study, beyond initial patient inclusion.

Patient confidentiality will be maintained at all times.

Patient folders will not be removed from the hospital premises for data collection.

All relevant data will be stored on a password protected hard drive at all times.

This study adheres to the Declaration of Helsinki 2008.

FUNDING

No external funding is required for this research.

REPORTING

The study and its results will be the basis for a dissertation for the M.Phil. (Emergency Medicine) at the University of Cape Town.

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Part B: Literature Review

Introduction:

Blood cultures are important in the management of patients. Apart from assisting with diagnosis, blood cultures also help identify antibiotic resistance and sensitivity patterns which assist both in local and national planning. This data is important in the decision on when to take a culture and how best to manage a patient who may be exposed to pathogens outside the hospital ¹.

Blood cultures are one of the most commonly performed investigations in the Emergency Centre. Compared to family physicians, Emergency Physicians order almost 7 times the number of blood cultures in certain patients ², and many emergency based guidelines, such as the Surviving Sepsis Campaign guidelines³ dictate blood cultures as part of a patient's management. They are obtained most commonly to determine the causative pathogen of a presumed bacterial infection or less commonly, to exclude a bacterial source of a disease process. Unfortunately, blood culture results are often only available several days after they are obtained, with the patient either admitted into a ward at the same or different hospital or discharged home with outpatient medication. Guidelines may also overestimate the number of eligible patients for blood culture ⁴, although blood cultures are still performed with the basis of the guidelines in mind. Some perceived requirements for blood cultures (such as a burns patient) have had their guidelines modified to dictate specific cultures only (such as tissue cultures only) ⁵ but despite this, blood cultures are performed on many patients where it will have little bearing on their management.

In South Africa, emergency medicine is practiced in varying settings with a wide range of access to special investigations. Emergency Centres are often staffed by fairly junior personnel, and in some cases only nurses will be present at all times in the Emergency Centre. Public health facilities also have limited budgets to provide emergency services to the public and rationalisation of resources is undertaken to ensure that the local communities have access to services they require more often. Pressure is also placed on emergency centres to discharge patients when possible to alleviate the stress placed on overburdened healthcare facilities.

South Africa also has one of the highest rates of HIV and other infectious diseases in the world. This complicates acute care presentation of disease and makes the decisions to admit patients or discharge patients more complex than in many developed countries.

Blood cultures are fairly costly in the South African setting, both from equipment and labour perspectives, and require adequate technique and circumstance to perform properly and obtain results that are a true reflection of a patient's potential bacteraemic state.

For a test to be truly useful in a clinical setting, it should be easy to perform, provide results in a timely fashion and, importantly, affect the management of the patient based on what results are obtained. When blood cultures are assessed against these criteria, it appears that their utility may already be limited by the way in which blood cultures must be obtained (requiring a strict aseptic technique, multiple cultures taken at different times and dates and from different sites) as well as the time it takes to obtain results (several days). The effect on clinical care and patient management should thus override the difficulty in performing a blood culture adequately to make the test useful in the emergency setting.

The apparent limited utility of blood cultures in an emergency setting prompted a review of literature to assess if there were indications that blood cultures are less warranted in the emergency setting and if there are alternative tests that are more appropriate in an emergency centre that can give similar results in a shorter space of time. The review also aimed to assess what the normal contamination rates for blood cultures are, and what methods may be used to limit this in an emergency setting.

The objectives of the literature review can be summarised as:

- Is there existing evidence that directs judicious use of blood cultures in the emergency centre?
- What methods are considered appropriate for blood culture collection?
- What markers, if any, may be more suitable for assessing bacteraemia or infection in a patient as opposed to blood culture?

Literature Search Strategy:

A PubMed search was conducted using the terms "Blood Cultures in the Emergency Department" which revealed over 750 articles. A BestBets (www.bestbets.org) search was also done using the terms "Blood Cultures in the Emergency Department" which

revealed no articles. This was narrowed to “Blood Cultures” which revealed 3 articles. A following search of “Blood cultures in HIV in the Emergency Department” revealed 18 articles.

These articles were then scanned by title for relevance to the desired search criteria of:

- Blood cultures performed in the Emergency Centre
- Blood culture contamination
- Alternatives to blood culture as a marker of bacterial infection
- Techniques of blood culture, including skin preparation
- Guidelines or rules for blood culture utilisation e.g. clinical prediction rules

Articles not relevant to the above criteria were excluded.

Quality Criteria:

Articles were assessed for quality on the basis of Study Bias (in particular Selection and Attrition), date of research, number of references and composition.

As the majority of the studies were retrospective reviews, it was difficult to apply stringent quality measures to each article as, by their nature, they were limited in data availability.

Summary and Interpretation:

Thematically, there were three main areas studies in the literature, namely utility of blood cultures performed in the emergency centre (including contamination rates and other factors supporting or limiting their usefulness), alternatives to the use of blood cultures that may prove more efficient from a time or cost perspective (including clinical rules and guidelines as well as alternative biomarkers) and lastly how technique in obtaining the blood culture may ultimately affect the result of the culture. All of these factors have significant relevance to the South African emergency setting, where beds, staff and funds are limited, and the utility of any commonly used investigation must be reviewed often to assess if there are more suitable alternatives with the progress of medical science and the dynamics of disease demography.

In order for blood cultures to be useful in the assessment of a patient's suspected bacteraemia, the blood culture will need to reflect pathogens cultured from the patient's blood only. As such, poor technique and subsequent contamination play a major role in degrading results of the culture. False positive results due to contamination (defined as

bacteria not present in the patient's blood that are grown in culture) add significantly to a health institutions costs through increased costs of IV antibiotics, laboratory fees and microbiology costs and result in a higher patient admission time ⁶. The interpretation of false positives can also prove to be difficult at times as one must decide if the organism is pathogenic or merely just a contaminant ⁷. Hall and Lyman describe organisms that ordinarily always reflect true positives as well as the most common organisms that are contaminants ⁷, but in South Africa this may not be the case, especially in light of the country's high HIV rate and more complex clinical milieu. HIV positive patients have been shown to have a much higher rate of positive blood cultures, with up to 24% with a provisional diagnosis of community acquired pneumonia being bacteraemic on testing ⁸. HIV patients also have a higher rate of complications than immune-competent patients ⁸, and so decisions regarding blood cultures in these individuals are more complex.

Proper technique alone has been shown to reduce contamination rates to as low as 0.8% of specimens, whereas less adequate attention to patient preparation and culture technique may lead to contamination rates as high as 7.8% ⁹. It is also important to assess decontamination of equipment in a hospital facility, as even with the most scrupulous of blood culture techniques, up to 25% of equipment may remain contaminated with bacteria after hospital cleaning, which negates the benefit of hand washing or aseptic cultures ¹⁰.

Techniques for obtaining blood cultures vary depending on institution. This in itself may present problems due to non-standardised techniques, but institution specific training needs to be conducted in order to minimise risks of contamination. It is generally the most junior (and hence most inexperienced and untrained) medical staff who order and obtain blood cultures ¹¹ which increases the risk of blood culture contamination. Gander, Byrd et al showed that trained phlebotomists have much lower blood culture contamination rates than non-trained personnel (3.1% compared to 7.4%) which translated into direct cost savings for the hospital due to shorter patient stays and lower medication and laboratory costs ¹².

Proper blood culture technique takes into account the method of obtaining blood from the patient as well as what media the blood is transferred to in order for bacteria to be cultured adequately.

Several studies have looked at what skin disinfection is the most appropriate for using when obtaining blood cultures. Between the most common preparations (70% isopropyl

alcohol (IPA); 10% povidone iodine (PI); iodine tincture and IPA + PI) it appears that there is little significant difference between their efficacy ^{6, 13} and as such IPA may be more useful due to its generally low cost. Mention was made of technique being arguably more important than the disinfectant used ¹³, as the practitioner should wait for the disinfectant to dry prior to obtaining the culture.

Ideally, blood should be obtained from more than one site at the time of culture to maximise the potential for a positive bacterial yield in a culture. Additional samples should also be obtained during the initial 24 hour period. In an emergency centre, practitioners are usually pressured for time with high patient volumes and acuity. In South Africa, the public health service has limited staff available at any time, and an expectation for staff to obtain multiple cultures is most likely misplaced. Patients are also usually transferred or admitted within 24 hours, which would place the responsibility on obtaining further cultures on the admitting doctor, which may also become problematic. Unfortunately, this limits the value of blood cultures somewhat as Lee, Mirret et al demonstrated that up to 4 cultures within 24 hours may be needed to obtain a 99.8% yield of bacteria, and a single culture may produce a yield as low as 73.1% ¹⁴. It would appear then that logistical obstacles would limit the value of blood cultures in the emergency setting unless the required amount of cultures can be performed within 24 hours.

The media used for culture is also important in obtaining a proper yield of bacteria. Up to 6.5% of cases cultures may be anaerobic and multiple factors influence their accuracy, including sample techniques, transport to the laboratory and what media is used ¹⁵. 3 bottles are recommended for each culture, namely a CO₂ bottle, aerobic bottle and anaerobic bottle to maximise yield ¹⁵, but in a South African emergency setting this would be very cumbersome and difficult to perform given their current constraints.

A summarised suggestion of the correct blood culture technique is presented below:

1. Staff to wear sterile gloves during preparation and blood collection
2. Disinfection of the puncture site (using either isopropyl alcohol or povidone iodine or combination), allowing the disinfectant to dry fully prior to venepuncture
3. Collection of blood from 2 separate sites at the initial time of collection

4. Replacing needles used for venepuncture with sterile needles to be used for inoculation (local protocols may prevent this due to the higher risk of Needlestick injury)
5. Inoculation of at least 10 ml blood (per site) into EACH of:
 - a. Aerobic culture media bottle
 - b. Anaerobic culture media bottle
 - c. CO₂ culture media bottle
6. Patient re-culture a further two times during the initial 24 hour period from admission

Several studies have looked specifically at the utility of blood cultures in an emergency or ambulatory setting. As mentioned previously, and is confirmed by some studies, due to the length of time it takes for results to be obtained from blood cultures, clinical judgement is most often used to determine whether or not a patient is admitted or discharged, not the blood culture result ^{16, 17}.

When determining if blood cultures are useful, they must make an impact on patient management. Ehrenstein et al commented that in an emergency department they surveyed, 97% of cases had no therapeutic consequences when results were negative ¹⁸. In the same study, only 15 % of physicians surveyed rated blood cultures as necessary in determining treatment and in 7 out of 10 cases where narrowing of antibiotic treatment was expected to be narrowed based on the results of the cultures, the therapy was in fact broadened, further indicating either a lack of understanding as to the results or negating any benefit in doing the test in the first instance.

This trend is echoed in several other studies. Rates as low as 0.2% of blood cultures taken affecting management were noticed in one study by Smith and Khan ¹⁹, but the same study also noted marked local variation in these rates. Other studies show rates of between 1.6% and 5% of blood cultures influencing management ²⁰⁻²², with the highest rate being obtained in patients with known or suspected community acquired pneumonia ²². Importantly, the positivity rates in these studies varied between 9% and 18%, with approximately half of all these cases being true positives ¹⁹⁻²¹. This trend is worrying in that decisions then rest with clinicians as to which cultures have clinical significance and antibiotic utilisation is likely to escalate as a safety net for these patients, leading to higher and unnecessary costs and patient discomfort.

Ambulatory patients (patients discharged from the emergency centre or outpatients) are even less likely to have positive blood cultures. Whilst up to 11% of patients with community acquired pneumonia who are admitted have positive blood cultures ¹⁶ in one study, of the 7% of ambulatory patients with positive blood cultures, there were no true bacteraemias noted ²³. Guidelines for pneumonia tend to advocate blood cultures in patients to be admitted only, but this may not be reflected in practise ²² with the added burden of these patients requiring follow up and call back in the event of the blood culture being positive.

Whilst these studies are limited in some respects (some being retrospective only and all having low patient numbers), they certainly point to the need for revision to the criteria for blood cultures in the emergency centre.

Guidelines exist for many conditions that present to the emergency centre, and many of these pertain to infectious diseases and will include blood cultures in their regimen. The difficulty in emergency centre staff using guidelines is that, whilst useful in general, guidelines may not be relevant to local situations or disease profiles and may not be readily accessible by staff in the emergency centre.

Guidelines are often safe in terms of management. Clinicians will rather be safe in their approach to patients than risk clinical rules that are untested in their environment, for example, the standard of care in meningitis is to give antibiotics until cultures (blood or cerebro-spinal fluid) are available. 5 clinical decision rules are available for differentiating viral to bacterial meningitis in children, of which 2 are highly sensitive and specific ^{24, 25} but further validation needs to be done before they are widely accepted.

Many of the guidelines are difficult to implement and operate in ideal circumstances, as they require close attention to detail and impeccable patient follow up. These are difficult to perform in most emergency centres. For example, management of severe sepsis requires that blood cultures be obtained prior to the administration of antibiotics (if practical) and that at least one culture should be percutaneously obtained. Subsequent cultures should then be obtained from each vascular access point in place for over 48 hours and other sites as needed ³.

Other rules tie in to more common sense clinical criteria, such as age and environment ^{26, 27} or nonspecific scoring systems, such as the Modified Acute Physiological Score ²⁸, the Clinical Pulmonary Infection Score ²⁹ or the Philadelphia criteria for infant sepsis ³⁰.

These studies stress the importance of attention to detail and meticulous follow up. In the emergency centre setting, however, junior staff and regular staff rotations make this very difficult ³¹ and in the South African environment, access to patients via telephone or other means is impossible in some cases.

Ideally then, a test would exist that provided rapid results and was sensitive and specific for bacteraemia. A few studies have looked into these markers or tests, not with a view to replacing blood culture, but perhaps to aid in the decision as to when it is appropriate to order blood cultures on patients, and maximise the yield.

C-Reactive Protein (CRP) is a commonly ordered marker to assess the presence of infection. Whilst cheap compared to many other markers and very sensitive, CRP lacks specificity for infection ³². CRP velocity (the ratio between CRP value on admission and the number of hours after the onset of fever) is perhaps more useful in differentiating between bacterial and non-bacterial infections than a pure CRP value alone ³³. In the South African setting, the value of this is limited by adequate history (time of onset of fever) as well as the study excluding HIV positive patients, as well as those with malignancy or who have used antibiotics recently. CRP also has a statistically significant age/velocity relationship, and is usually lower in older patients. This may not have any clinical significance, however ³⁴.

Pro-calcitonin (PCT) may also be used as a bio-marker in infections. It is more expensive than CRP, but more specific for bacterial infections ³⁵. PCT is better for judging the severity of infection ^{32, 36, 37} and possibly assessing specific diseases such as meningitis and pneumonia and may reduce total antibiotics given in these diseases ³². It is the best diagnostic and prognostic marker in severe sepsis ³⁸. It may help to distinguish between bacterial and non-bacterial infections ³⁹, but Hausfater et al concluded that Emergency Physician judgement is as good as or better than PCT assay and may help support the assessment of cause and prognosis of illness in the emergency centre ³⁷.

Real Time Polymerase Chain Reaction (RT-PCR) has also shown to be effective as a biomarker or assay in the emergency centre. RT-PCR is a combination of PCR chemistry and fluorescent probe detection in the same vessel. It can be completed in less than one hour with similar sensitivity and specificity as normal PCR and Southern Blot testing ⁴⁰. As blood cultures often take too long to impact management, a study by Jordan and Durso showed that RT-PCR assisted in the diagnosis of ill infants and aided in differentiation between other “sepsis mimickers” such as hypoglycaemia, transient

tachypnoea of the newborn and delayed transition and reduced antibiotic use in these patients ⁴¹. Whilst this is an expensive test, the benefits of getting a diagnosis and causative pathogen early may mitigate its costs through reducing unnecessary admission and antibiotic use in hospitals.

Need for Further Research:

Much research has been done in developed countries regarding the utility of blood cultures. Unfortunately, as mentioned previously, South Africa is unique, both in terms of disease burden and available resources in the health department. Most of the studies were retrospective, with the prospective studies having small quantities of patient data.

These studies, whilst beneficial and helpful in indicating that there are deficiencies with blood culture testing in ambulatory and emergency scenarios, need to be validated in a South African context.

Of particular interest, is the utility of blood cultures in the South African context. With such small percentages of cultures making a demonstrable difference in patient management, it is quite likely that this is echoed locally. Ideally, a prospective randomised controlled study could investigate the differences between current practices and blood culture results (contamination rates, how many affected management) vs “ideal” practices in technique (combining all the best practices suggested by the authors (aseptic technique, disinfectant, number and type of media bottles used)).

The study of Archibald et al ⁹ regarding contamination of equipment also suggests that an audit of contamination rates of small hospital equipment may be of benefit in the South African context.

The article by Gander et al demonstrating the lower contamination rates of trained phlebotomists also warrants further investigation. Whilst phlebotomists are not readily available in the public sector, the private sector may reveal some interesting results and motivation for employing trained staff in the public setting to improve phlebotomy and ultimately save on costs.

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Part C: Study

An Evaluation of Blood Cultures in the Emergency Centre

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Dr Fleming was responsible for the conception and design of the study, acquisition and analysis of data and drafting the article.

Dr Geduld was responsible for the design, revision for critical intellectual content and final approval for submission.

Conflicts of Interest:

Dr Fleming incorporated this article into a final dissertation submission titled “An Evaluation of Blood Cultures in the Emergency Centre” and submitted to the University of Cape Town Faculty of Health Sciences for partial fulfilment of criteria for the degree Master of Philosophy in Emergency Medicine.

University of Cape Town

1. Abstract

Introduction

Several international studies have demonstrated a low utility of blood cultures in ambulatory and emergency patients. Given South Africa's unique burden of disease and challenges in the public healthcare system, it was questioned if these results would be true in the local context.

Methods

A retrospective review of blood cultures over a 9 month period was undertaken at GF Jooste Hospital in Cape Town, South Africa. Files were assessed for initial diagnoses, antibiotic therapy, diagnoses and therapy and overall utility of the cultures was determined. A secondary part of the study used questionnaires handed to Emergency Centre medical staff to determine experience, levels of training and basic blood culture technique and determine if there were any correlations.

Results

1578 blood cultures were collected in the hospital over the study period. 973 were performed in the Emergency Centre. 21.5 % (n=209) were positive. 90 files were included in the review.

64.4 % (n=58) of positive cultures were contaminated. Poor documentation also contributed to the poor overall utility of only 0.2 % of all cultures performed.

Questionnaire results showed a correlation between training and technique, as well as experience and the likelihood of obtaining blood cultures in patients discharged later in the shift.

Conclusion

Blood culture utility is low in the Emergency Centre environment both internationally and in South Africa, despite the differences in disease profiles and working conditions. It is suggested that alternative tests are used to refine which patients will benefit from blood cultures the most.

Training and protocol development may assist in reducing the number of false positive blood cultures as well as directing clinicians to use these tests more appropriately.

It is recommended that additional studies are undertaken in a prospective multi-centre method to both validate and possibly improve on the results of this study.

Keywords

Blood Culture; Emergency; Contamination; South Africa

University of Cape Town

2. Introduction

Blood Cultures are one of the most commonly utilised investigations in the Emergency Centre (EC). They are often used to identify the causative organism in a disease process or to assess the resistance of a known organism due to treatment failure.

Many patients who present to the Emergency Centre do so with a febrile illness ¹. Most of these cases have simple aetiologies but in some cases the presentations may be more complicated, especially if there are co-morbid diseases such as HIV.

In South Africa, there is a high incidence of infectious diseases as a cause of morbidity and mortality in the adult population, most notably HIV. HIV is estimated to affect about 11% of the total population although this rate depends on province and has sex and race disparities ². This high rate of HIV can make diagnoses in the EC more complex as well as raise concern about uncommon pathogens causing disease in the patient. The difficulty is assigning the “contaminant” label to a blood culture in an HIV positive patient is also more difficult than an immuno-competent patient and techniques to limit contamination, such as “double needles” may present risks to the clinician ³.

To maximise value from blood cultures, the test needs to be performed with the correct technique so as to minimise the risk of contamination and maximise the yield of bacteria^{4, 5}. Unfortunately, most South African EC's do not have adequate equipment or staff available to perform these tests as meticulously as they should be performed, which may limit the value of blood cultures in this setting.

GF Jooste Hospital is a secondary level hospital located in Manenberg on the Cape Flats in the Western Cape province of South Africa. It serves a drainage area of approximately 1.3 million people, of which 43% of the population are unemployed ⁶. There is a high rate of HIV in the drainage area, and the burden of other infectious diseases, compounded by poverty, is also high⁷. This “quadruple burden of disease” consisting of conditions related to underdevelopment, injuries though trauma, non-communicable diseases and HIV/AIDS comes at significant cost to the province ⁷.

The EC sees approximately 4500 patients per month of which almost 13% are admitted into the main hospital ⁶. The hospital employs a range of medical staff who work in the EC with varying experience levels, which is fairly representative of most secondary level hospitals throughout South Africa.

There are several factors that may prevent the South African public healthcare system from maximising the utility of blood cultures. These include the limitation of human resources combined with high patient load (little time to spend taking the cultures, and multiple samples not performed), lack of proper equipment (no anaerobic bottles available, difficulty in obtaining sterile packs) and bed pressure (early discharge may result in patients leaving the facility prior to results being obtained). Not all are unique to South Africa, and some, such as poor note taking and documentation will affect the utility of the blood culture as much as using the incorrect technique.

Given the factors above, it was theorised that blood cultures performed in the emergency centre have very little actual benefit to patients and more efficient or cost effective alternatives should be considered and investigated to be used to direct the more judicious use of these costly investigations.

The aim of this study is to determine whether routine blood cultures performed in a secondary level hospital Emergency Centre affect the choice of antibiotic used in treating patients with bacterial infections.

A secondary aim is to determine if staff in the EC are aware of correct procedures for drawing blood cultures, and whether their practice reflects this.

3. Methods

This is a two part study. Part 1 was a review of the case records of patients who had a positive blood culture performed in the EC at GF Jooste. Part 2 is a questionnaire based survey of staff working in the EC as to training, indications and methods of performing blood cultures in the EC.

Ethics approval was obtained from the UCT ethics committee and provincial government approval was obtained prior to the research commencing.

3.1 Review of Blood Cultures

A retrospective review of the files of all patients with positive blood cultures who presented to G F Jooste Hospital Emergency Centre between April 2008 and November 2008 (the initial 12 month study period was limited to 9 months due to difficulty in obtaining case files and clearly significant results even within the limited sample) were analysed for:

1. Date of Culture and Result

2. Type of Culture Medium
3. Result of the Culture
4. Date of Discharge of the Patient
5. Initial EC Diagnosis
6. Initial EC Treatment
7. Ward Diagnosis, or change in diagnosis
8. Change in Treatment
9. HIV status
10. Anti-retroviral status

The data collected was expanded from the initial study protocol as further literature review presented important variables that were not included in the initial protocol.

Culture results were assessed using criteria discussed in Updated Review of Blood Culture Contamination³, specifically by isolates. Discussion with the National Health Laboratory Services (NHLS), who are responsible for public service laboratories across the country, confirms they use international criteria, such as those of Hall and Lyman. A table of pathogens is included in Appendix A.1, Table 4.

Patient Identification:

All patients receiving blood cultures during the study period at GF Jooste Hospital were identified from the laboratory database. This list was refined by excluding all cultures not identified in the database as being performed in the Emergency Center. Patients with positive results were selected and entered onto the study database, whilst a random selection of 15% of patients with negative results were identified for comparison.

Data Collection:

The data was collected by the principal author to limit variability in data entry.

Inclusion Criteria:

- Age 18 or greater
- Blood culture performed by EC staff in EC
- Recorded blood culture result by laboratory

Exclusion Criteria:

- Age < 18
- Blood culture done by non EC staff or on ward
- No final blood culture result available
- Patient transferred to another facility before blood culture result available

Confidentiality:

The data was entered onto the study database with only the patient number being present as an identifying feature. This database was maintained on the author's computer as a password protected, encrypted file that was only accessible by the author. All initial analysis was conducted by the author, and subsequent content review was done on data presented anonymously to the review author.

3.2 Questionnaire

A short questionnaire was handed to medical staff in the GF Jooste EC in an attempt to assess aspects of blood culture technique that may affect the quality of the results obtained by the culture. 25 questionnaires were distributed and answers collated to for analysis.

Staff Identification:

All full time staff working in the Emergency Center across each shift were given questionnaires to complete. Questionnaires were handed to a senior EC staff member for dissemination and then handed to the author after completion to maintain anonymity amongst the staff.

Inclusion Criteria:

- Permanent Medical Staff who work in the Emergency Centre
- Questionnaire filled in fully

Exclusion Criteria:

- Non-Permanent Staff
- Ambiguous or spoiled answer sheets
- Unfilled Answers

4. Results:

1578 Blood Cultures were performed at GF Jooste Hospital between 1 April 2008 and 31 October 2008. Of these, 973 (61.7%) were labelled as having been obtained from the Emergency Centre. 209 (21.5%) of the blood cultures obtained in the EC were positive.

Only 120 (57.4 %) files were able to be located, and of these files, 90 (43.1 %) were included into the study, the rest being excluded for the blood cultures being obtained by non-EC staff (6.7 %, n=14), inadequate clinical notes or documentation as to who performed the blood culture (6.2 %, n=13) or culture results not being available in the laboratory (1.4 %, n=3).

115 files were randomly selected to form a negative result comparison. Only 59 (51.3%) of these files were able to be located. Of the files located, 41 (35.7%) were included, the rest being excluded for being underage (0.9%, n=1), inadequate clinical notes (7%, n=8) or the blood cultures being performed by non EC staff (7.8%, n=9).

4.1 *Average Length of Stay*

Blood Culture Positive:

The average length of stay (ALOS) was 6.6 days (Mean 6.6, Standard Deviation 6.5). 9 clinical notes made no mention of a discharge date and were excluded from ALOS calculation.

Blood Culture Negative:

The ALOS of patients with negative blood cultures was slightly lower (Mean 6.2, Standard Deviation 6.4).

4.2 *HIV status*

Blood Culture Positive:

45 (50%) of patients were documented as being HIV positive with 8 (8.9%) being documented as HIV negative. The remaining patients were either unknown HIV status (17.8 %, n=16) or there was no mention of their status (23.3 %, n=21).

Of the patients with HIV, 11 (24.4%) were on Highly Active Antiretroviral Therapy (HAART). 8 (17.8%) of the HIV positive patients had a CD4 count of below 200, 6

(13.3%) had a CD4 count of greater than 200 and 24 (53.3%) had an unknown CD4 count. The remainder (15.6 %, n = 7) had no mention of their CD4 count in the notes.

Blood Culture Negative:

25 patients (61%) were documented as being HIV positive with only 3 (7.3%) being documented as HIV negative. Unknown or undocumented HIV status (31.7%, n=13) made up the remainder of cases.

28% (n=7) of these patients were on HAART. 48% (n=12) of the HIV positive patients with negative blood cultures had CD4 counts below 200 with the remainder either having CD4 counts of above 200 (16%, n=4) or having CD4 counts undocumented (36%, n=9).

4.3 *Culture Media*

Blood Culture Positive:

Of the 90 included cases, only 57 (63.3%) of the cases had blood culture samples documented as an Aerobic media bottle.

No patients had Anaerobic or other media bottles indicated as part of the blood culture (not available in the hospital).

Blood Culture Negative:

56% of the cases (n=23) were documented as having aerobic culture media used.

No other media was documented in any of the cases recorded.

4.4 *ER Diagnoses*

Blood Culture Positive:

26 (28.9 %) of the patients were diagnosed with a respiratory focus of infection (Lower respiratory tract infection or community acquired pneumonia). 17 (18.9 %) of the cases were noted to have sepsis as part of the diagnosis. 12 (13.3 %) of cases had meningitis as part of the preliminary diagnosis.

Urinary Tract Infections affected 4 (4.4 %) of the patients and an abdominal (non-urinary) focus (usually gastroenteritis) affected 12 (13.3 %) of the cases.

6 (6.7 %) of the cases had diagnoses not directly related to causes of bacteraemia, including subarachnoid haemorrhage (presumed to possibly include meningitis as a differential although this was not noted), pseudo seizures and viral hepatitis.

The diagnoses of the Emergency Centre staff only correlated with 42 (46.7 %) of the cases reviewed by the admitting staff.

Blood Culture Negative:

Respiratory foci accounted for 41.4% (n=17) of cases cultured. Meningitis (19.5%, n=8) and sepsis (9.8%, n=4) made up the majority of other diagnoses from the EC. 3 cases (7.3%) had diagnoses not directly attributable to bacterial causes.

Correlation between admitting and EC medical staff was better in this group, with 75.6% (n=31) of cases having similar diagnoses.

4.5 Initial Emergency Therapy

Blood Culture Positive:

The majority of the cases in the EC were treated with broad spectrum antibiotic cover. Ceftriaxone was utilised in 61 (67.8 %) of the cases and in 51 (56.7 %) of patients, it was the only antibiotic used.

14 (15.6 %) of the cases did not receive any antibiotics from the Emergency Centre at all.

Initial EC antibiotics and corresponding diagnoses are listed in Appendix A1.

Blood Culture Negative:

Once again, Ceftriaxone was used in the majority of cases (63.4%, n=26) and was the only antibiotic used in 20 (48.8%) of the cases.

19.5% of cases (n= 8) did not receive any antibiotics in the EC.

4.6 Changes in Therapy and Blood Culture Utility

Blood Culture Positive:

Changes to therapy occurred in 53 (58.9 %) of the cases in the study. 36 (40 %) of the patients had their therapy broadened and 18 (20 %) of the patients had therapy

narrowed. 2 of the cases had therapy changed to oral medication for discharge, but retained similar spectrum of cover.

However, only 16 (17.8 %) cases had the blood culture results documented in the clinical notes and of these 5 (5.6 %) had clinically significant pathogens present, however therapy was modified in only 2 (2.2 %) cases.

The utility can be calculated as 2.2 % (n=2) of positive cultures (using the 90 cases included in the study), or an overall blood culture utility of 0.2 % (of all cultures performed in the Emergency Centre).

Blood Culture Negative:

Changes to therapy by the admitting specialty occurred in 15 (36.6%) cases, with 7 (17.1%) of the cases having the therapy broadened and the remainder (19.5%, n=8) having therapy narrowed.

Only 1 case had the negative result recorded in the notes. The patient was diagnosed with disseminated tuberculosis and therapy consisted of anti-tuberculous medication with ceftriaxone, which was not modified after the result was documented.

4.7 Contamination

Whilst multiple isolates from a culture may suggest contamination, this criterion was not used in this instance and cases will be commented on individually where this occurs.

The true positive rate for cultures in the Emergency Centre was 37.8 % (n =56) of the positive specimens (5.8 % of the total cultures obtained).

The results are indicated in Table 1 below.

Table 1: Blood Culture Contamination by Isolates

| Isolate | Percentage of Cases % (n) | Contaminated Specimen | Comments |
|-------------------------------------|------------------------------|-----------------------|---|
| Staph. Epidermidis | 50 % (45) | Yes | |
| Strep. Pneumonia | 8.9 % (8) | No | |
| Diphtheroids | 6.7 % (6) | Yes | |
| E.Coli | 5.6 % (5) | No | |
| Micrococcus | 3.3 % (3) | Yes | |
| Strep. Gordonii | 1.1 % (1) | No | Patient Died |
| Haem. Influenzae | 1.1 % (1) | No | |
| B Haem. Strep. A | 1.1 % (1) | No | |
| B Haem. Strep. B | 1.1 % (1) | No | |
| Salmonella B | 2.2 % (2) | No | |
| Salmonella D | 1.1% (1) | No | |
| Proteus Mirabilis | 1.1 % (1) | No | |
| Cryptococcus Neoformans | 1.1 % (1) | No | |
| Pseudomonas Aeruginosa | 1.1 % (1) | No | |
| Klebsiella Pneumoniae | 1.1 % (1) | No | |
| Neisseria Meningitis | 1.1 % (1) | No | |
| Staph. Aureus | 2.2 % (2) | No | |
| Chryseobacterium Indologenes | 1.1 % (1) | No | |
| Gram Positive Cocci in Chains | 1.1 % (1) | No | Lost viability before identification – probable S. Pneumonia |
| Strep. Salivarius/Strep. Mitis | 1.1% (1) | Yes | Unlikely Pathogens |
| Staph.Aureus/Staph. Epidermidis | 1.1 % (1) | No | Patient Died |
| Staph. Epidermidis/ Diptheroids | 1.1 % (1) | Yes | Both considered contaminants |
| Proteus Vulgaris/ E.Coli | 1.1 % (1) | No | Patient Died |
| E.Coli/ Salmonella D | 1.1 % (1) | No | Patient Died |
| Strep.Pneumonia/ Staph. Epidermidis | 1.1 % (1) | Yes | Patient diagnosed with Pneumonia |
| Candida Albicans/ Diptheroids | 1.1 % (1) | Yes | Patient Died |

4.8 Discharge Prior to Results

Table 2: Patients Discharged Prior to Blood Culture Results being Available

| Culture Result | Number of Cases % (n) | Comments |
|------------------------|--------------------------|--|
| <i>False Positives</i> | | |
| S. Epidermidis | 75 % (24) | |
| Diphtheroids | 9.4 % (3) | |
| Micrococcus | 6.3 % (2) | |
| <i>True Positives</i> | | |
| S. Pneumoniae | 3.1 % (1) | Diagnosed with Pneumonia, Treated with Ceftriaxone |
| C. Indologenes | 3.1 % (1) | Of doubtful Clinical Significance |
| N. Meningitidis | 3.1 % (1) | Diagnosed with PNEUMOCYSTIS CARINII PNEUMONIA, Treated with Ceftriaxone and Co-Trimoxazole |
| Total | 100 % (32) | |

44.4 % (n=40) of the cases were discharged or died prior to the results of the cultures being made available by the pathology laboratory. 8 (20 %) patients died prior to results.

4.10 Questionnaires

25 questionnaires were distributed, of which 25 were received back from the staff. Of these 25, 1 questionnaire was excluded due to the respondent being a non-permanent staff member and 1 questionnaire was excluded as it was not fully completed.

The results of the responses are indicated in Appendix A.2 -Table 5.

An Evaluation of Blood Cultures in the Emergency Centre

Table 3: Questionnaire Responses

| | Regularly Perform Blood Cultures | Aware of Protocols for Performing Blood Cultures | Trained to Perform Blood Cultures | Take Specimens from Peripheral Cannula | Take Specimens from Routine Blood Samples | 70% Iso- Propyl Alcohol Swab for Disinfection | Liquid Based Antiseptic for Disinfection | Separate needles for Inoculation | Regularly perform cultures on patients discharged | Aware of differences between Aerobic and Anaerobic Media |
|---------------|--|---|---|--|--|---|--|--|--|---|
| | % (n) | % (n) | % (n) | % (n) | % (n) | % (n) | %(n) | % (n) | % (n) | % (n) |
| Total (n=23) | 100% (23) | 8.7% (2) | 69.6% (16) | 4.3% (1) | 47.8% (11) | 8.7% (2) | 91.3% (21) | 60.9% (14) | 65.2% (15) | 34.8% (8) |
| Interns (n=9) | 100% (9) | 0% (0) | 100% (9) | 0% (0) | 0% (0) | 0% (0) | 100% (9) | 100% (9) | 66.7% (7) | 22.2% (2) |
| CSMO (n=7) | 100% (7) | 0% (0) | 14.3% (1) | 0% (0) | 85.7% (6) | 0% (0) | 100% (7) | 0% (0) | 85.7% (6) | 0% (0) |
| SMO (n=5) | 100% (5) | 20% (1) | 100% (5) | 0% (0) | 60% (3) | 40% (2) | 60% (3) | 100% (5) | 20% (1) | 0% (0) |
| Other (n=2) | 100% (2) | 50% (1) | 50% (1) | 50% (1) | 100% (2) | 0% (0) | 100% (2) | 0% (0) | 50% (1) | 50% (1) |

Notes:

1. Intern - Post Graduate Year (PGY)1 to PGY2
2. CSMO - PGY3
3. SMO - PGY4 to PGY5
4. Other - 1 Specialist Registrar and 1 Consultant

5. Discussion:

The study identified many potential shortcomings in obtaining utility out of blood cultures performed in the Emergency Centre at GF Jooste Hospital.

Only a single sample was usually taken from the patient, and this consisted of only an aerobic culture bottle. Up to 4 bloods culture specimens should be obtained within 24 hours to near a 100 per cent yield of bacteria ⁴. This is impractical in most scenarios and certainly very expensive. In addition, every culture “episode” should consist of, ideally, 3 bottles of differing culture media (aerobic, anaerobic and CO₂) to maximise the potential of bacterial growth ⁸. The approach then, of a single culture bottle most commonly once in 24 hours, severely limits the yield and hence utility of the blood culture specimen without any other factors, such as contamination, follow up and change in management further adding limitations to their value.

Contamination rates were unacceptably high in the Emergency Centre. Less than half of all positive blood cultures grew bacteria that were deemed pathogenic. There are direct cost implications to false positive blood cultures, but also more subtle costs, such as increased days of admission in many cases, and the requirement to obtain further cultures to confirm contamination ⁹. Resource limited departments can still show low contamination rates as meticulous attention to skin preparation and technique has been shown to result in lower rates of contamination than better resourced emergency centres ¹⁰. It is not surprising that so many of the staff members sway from accepted culture technique (taking blood from routine blood samples and not “double needling”) to save time. This has a direct effect on contamination rates ¹¹. Whilst some concessions may have to be made on certain techniques that pose a risk to staff performing the cultures (such as the risk of needle stick injury in “double needling”), these need to be included in a protocol that is readily available to staff and the affect they have on contamination rates needs to be acceptable to all involved parties.

Staff in the GF Jooste Emergency Centre tend to be fairly junior, which may raise the potential for culture contamination ¹², and is demonstrated in this study to further complicate the use of blood cultures by potentially over-ordering cultures (in the case of culturing patients who are expected to be discharged later in the shift) to the relatively high rate of disparity between the emergency room diagnosis and final admission

diagnosis. Blood cultures have little utility in ambulatory patients ¹³⁻¹⁶ and the use of these tests should be limited in patients expected to be discharged.

Cultures appear to be over ordered in the study. This is supported by the fact that almost 15% of the blood cultures were obtained in patients who did not receive antibiotics in the Emergency Centre initially, indicating that the suspected diagnosis was unlikely to be of bacterial origin in these cases. Dedicated staff, such as phlebotomists could relieve medical staff of some pressure, whilst improving blood culture collection and saving costs in the long run ⁹.

Training appears to have an impact on technique, as evidenced by Table 3 (Questionnaire Responses) – Interns (100% admitted to training) showed increased adherence to accepted protocol – using separate needles for inoculation, not taking specimens from routine blood sample etc., whereas CSMO's who were trained in approximately 14% of cases showed a much higher rate of deviating from accepted practice. Whilst this wasn't directly correlated with contamination rates, it still suggests that training is likely to affect the results of the cultures. Experience also seems to both negatively affect practice (increasing "shortcuts" in blood culture technique), but conversely decreases the likelihood of obtaining cultures on patients who are to be discharged. This argument is supported across specialities in other studies ¹².

Whilst some studies show little difference in contamination rates between using liquid antiseptic versus simple 70% isopropyl alcohol swabs ^{17, 18} these specifically looked at iodine based liquid antiseptics, whilst GF Jooste uses Chlorhexidine based liquid antiseptic. Alcohol swabs are cheap and easy to use, and could be included in the protocols for skin decontamination and cleaning prior to culture collection.

It is clear that the quality of documentation needs to be addressed in the Emergency Centre as well as in the wards. The lack of documentation in the clinical notes regarding the results of blood cultures may not reflect the true incidence of culture results being seen and acted upon. With only 17% of the cultures having results documented in the clinical notes, it is apparent that even if there were the most specific criteria for blood culture specimen collection and meticulous disinfection with low contamination rates in the hospital, the utility of the test is limited purely due to the fact that the results seem to not be utilised in day to day clinical practice.

The relatively higher incidence of changes in therapy compared to actual documentation of the results of the blood cultures by medical staff suggests the use of clinical decision making and experience in changing therapy in the hospital, as opposed to evidence obtained in the laboratory. Twice the number of patients (36 versus 18) had therapy broadened after the initial Emergency Centre treatment than had their therapy narrowed. The 0.2 % of patients that had therapy narrowed after blood culture results were documented does seem to correlate with international studies of blood culture utility ¹⁹⁻²¹, supporting the claim that utility of the blood cultures is very limited in the Emergency setting.

In cases where negative blood cultures were obtained, the results broadly reflect the results obtained in the samples with positive blood cultures in terms of diagnoses, limitations and shortfalls in documentation. The correlation in average length of stay, initial medication and still high (albeit lower than the positive group) changes to therapy without documented culture results further reinforce the low utility and perhaps disregard that clinical staff have for this investigation

Limitations:

Unfortunately, the study suffered from several limitations. The study focussed on positive cultures as these rule in diagnoses and change management, which is more important in this setting.

Clinical files were difficult to obtain, and many of the folders did not contain the clinical notes needed to be included.

Many of the clinical notes were of a poor quality in documenting the patient's clinical presentation, differential diagnosis and subsequent management, which made interpretation for the study difficult and may have negatively influenced the results of the study.

Because of the retrospective nature of the study, not all the questions that were asked could be answered adequately with every file. The study also only took place at one facility, which may have institution specific shortcomings not present at other facilities.

6. Conclusion:

With South Africa having such limited resources in the public healthcare system, investigation into common practice and rationalisation of costs needs to occur to ensure that the most value is obtained when managing patients.

Whilst supporting international consensus that blood cultures have little demonstrable utility in the ambulatory or emergency setting, perhaps of more interest and concern is the lack of oversight and clinical guidelines that occur with regard to blood culture collection and the poor quality of note-keeping associated with the patients included in the study. It is possible, and indeed probable given the findings in this small review of patients, that improvement in basic care and documentation may improve patient care beyond just rationalisation of blood cultures.

The extremely high rate of blood culture contamination is costly to the hospital, both in terms of direct costs paid to laboratory services as well as time of medical staff spent following up results of patients who are most likely to only have contaminated cultures. Training in acceptable technique as well as formulating specific protocols on blood cultures is likely to have a cost benefit to the hospital, and will certainly benefit staff in their clinical practise.

This study should ideally be revisited as a prospective, multi-facility investigation into the use of blood cultures in Emergency Centres across the country. Assessing alternative and timelier investigations that may better direct clinicians to patients who may benefit from blood cultures is another aspect that should be investigated. If national consensus and protocols can be revised and strictly adhered to, the cost savings can be passed directly onto the hospitals, which will ultimately improve patient care.

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Appendix A

Additional Information

A.1 Table 4 – True Positive and Negative Culture Isolates

| True Positive Isolates | True Negative Isolates |
|-----------------------------------|--|
| <i>Staphylococcus aureus</i> | Coagulase-negative staphylococci |
| <i>Streptococcus pneumonia</i> | <i>Corynebacterium</i> species |
| <i>Escherichia coli</i> | <i>Bacillus</i> species other than <i>Bacillus anthracis</i> |
| <i>Enterobacteriaceae</i> | |
| <i>Pseudomonas aeruginosa</i> | <i>Propionibacterium acnes</i> |
| <i>Streptococcus pyogenes</i> | <i>Micrococcus</i> species |
| <i>Streptococcus agalactiae</i> | Viridans group streptococci |
| <i>Listeria monocytogenes</i> | Enterococci |
| <i>Neisseria meningitides</i> | <i>Clostridium perfringens</i> |
| <i>Neisseria gonorrhoeae</i> | |
| <i>Haemophilus influenza</i> | |
| <i>Bacteroides fragilis</i> group | |
| All <i>Candida</i> species | |
| <i>Cryptococcus neoformans</i> | |

Source: Hall KK, Lyman JA. Updated review of blood culture contamination.

A.2 Table 5 – EC Diagnoses

| BLOOD CULTURE POSITIVE | BLOOD CULTURE NEGATIVE |
|---|--|
| ASPIRATION PNEUMONIA | COMMUNITY ACQUIRED PNEUMONIA |
| ATYPICAL PNEUMONIA | COMMUNITY ACQUIRED PNEUMONIA/MENINGITIS |
| COMMUNITY ACQUIRED PNEUMONIA | CHOLECYSTITIS |
| COMMUNITY ACQUIRED PNEUMONIA | COLD ABSCESS |
| COMMUNITY ACQUIRED PNEUMONIA | CRYPTO MENINGITIS |
| COMMUNITY ACQUIRED PNEUMONIA | DIARRHOEA |
| COMMUNITY ACQUIRED PNEUMONIA/TUBERCULOSIS | DISSEMINATED TUBERCULOSIS |
| CONGESTIVE CARDIAC FAILURE, SEPSIS | DIABETIC KETO-ACIDOSIS |
| CEREBROVASCULAR ACCIDENT/HYPERGLYCAEMIA | DIABETIC KETO-ACIDOSIS/LOWER RESPIRATORY TRACT INFECTION |
| DELERIUM | DEEP VEIN THROMBOSIS/CELLULITIS |
| DELERIUM | DYSENTERY/TUBERCULOSIS |
| DELERIUM | GASTROENTERITIS |
| DELERIUM, URINARY TRACT INFECTION | GYNAECOMASTIA |
| DIARRHOEA, DEHYDRATION | HYPOGLYCAEMIA |
| DISSEMINATED INTRAVASCULAR COAGULATION | INTRACEREBRAL ABSCESS |
| DISSEMINATED TUBERCULOSIS | LOWER RESPIRATORY TRACT INFECTION |
| DIABETIC KETO-ACIDOSIS | LOWER RESPIRATORY TRACT INFECTION |
| DIABETIC KETO-ACIDOSIS, PNEUMONIA | LOWER RESPIRATORY TRACT INFECTION |
| DIABETIC KETO-ACIDOSIS/JAUNDICE | LOWER RESPIRATORY TRACT INFECTION |
| DM, CEREBROVASCULAR ACCIDENT | LOWER RESPIRATORY TRACT INFECTION |
| EMPHYEMA | LOWER RESPIRATORY TRACT INFECTION/PULMONARY TUBERCULOSIS |

An Evaluation of Blood Cultures in the Emergency Centre

| | |
|---|--|
| EMPHYEMA | LOWER RESPIRATORY TRACT INFECTION/PULMONARY TUBERCULOSIS |
| GASTROENTERITIS + PNEUMONIA | MENINGITIS |
| GASTROENTERITIS | MENINGITIS |
| GASTROENTERITIS | MENINGITIS |
| HAEMOPTYSIS | MENINGITIS |
| HEPATITIS | MENINGITIS |
| HYPOGLYCAEMIA | PANCREATITIS/SBP |
| LIVER FAILURE | PLEURAL EFFUSION |
| LOWER RESPIRATORY TRACT INFECTION | PNEUMONIA/CRYPTO |
| LOWER RESPIRATORY TRACT INFECTION | POST TUBERCULOSIS BRONCHIECTASIS |
| LOWER RESPIRATORY TRACT INFECTION | PULMONARY TUBERCULOSIS |
| LOWER RESPIRATORY TRACT INFECTION | PULMONARY TUBERCULOSIS |
| LOWER RESPIRATORY TRACT INFECTION | SPONTANEOUS BACTERIAL PERITONITIS |
| LOWER RESPIRATORY TRACT INFECTION, GASTROENTERITIS | SEIZURES |
| LOWER RESPIRATORY TRACT INFECTION, PULMONARY TUBERCULOSIS | SEPSIS |
| LOWER RESPIRATORY TRACT INFECTION/TUBERCULOSIS | SEPSIS |
| LOWER RESPIRATORY TRACT INFECTION/DIABETIC KETO-ACIDOSIS | SEPSIS |
| MENINGITIS | SEPSIS/LOWER RESPIRATORY TRACT INFECTION |
| MENINGITIS | SEPTIC ARTHRITIS |
| MENINGITIS | TUBERCULOSIS/LOWER RESPIRATORY TRACT INFECTION |
| MENINGITIS | |
| MENINGITIS | |
| MENINGITIS | |
| MENINGITIS | |
| MENINGITIS | |

| |
|-----------------------------------|
| MENINGITIS |
| MENINGITIS, ASPIRATION PNEUMONIA |
| MULTILOBAR PNEUMONIA/TUBERCULOSIS |
| PNEUMOCYSTIS CARINII PNEUMONIA |
| PNEUMOCYSTIS CARINII PNEUMONIA |
| PNEUMONIA |
| PNEUMONIA |
| PNEUMONIA |
| PSEUDOSEIZURES |
| PULMONARY TUBERCULOSIS |
| PULMONARY TUBERCULOSIS |
| PULMONARY TUBERCULOSIS |
| PULMONARY TUBERCULOSIS +/- SEPSIS |
| PYELONEPHRITIS |
| PYELONEPHRITIS |
| RESPIRATORY DISTRESS |
| SUBACUTE BACTERIAL ENDOCARDITIS |
| SEIZURES |
| SEIZURES |
| SEIZURES |
| SEIZURES |
| SEIZURES |
| SEPSIS |
| SEPSIS |
| SEPSIS |
| SEPSIS |

| |
|---|
| SEPSIS |
| SEPSIS |
| SEPSIS, GASTROENTERITIS |
| SEPSIS, HEPATITIS |
| SEPSIS, LOWER RESPIRATORY TRACT INFECTION |
| SEPSIS, TUBERCULOSIS IRIS |
| SEPSIS/MENINGITIS |
| SEPTIC ARTHRITIS |
| SEPTIC SHOCK |
| SEPTIC SHOCK |
| SEPTIC SHOCK |
| SUBARACHNOID |
| TUBERCULOSIS IRIS, GASTROENTERITIS |
| TUBERCULOSIS PERICARDITIS |
| TUBERCULOSIS, LOWER RESPIRATORY TRACT INFECTION |
| TUBERCULOSIS/GASTROENTERITIS/MENINGITIS |
| URINARY TRACT INFECTION/BACTERAEemia |
| VIRAL HEPATITIS |

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This article is entirely the original work of the Authors credited above. The principle author, Dr J Fleming was responsible for the majority of the work contained herein, including design, data collection and interpretation and initial drafting.

This article formed part of a submission for the degree Master of Philosophy in Emergency Medicine at the University of Cape Town, Faculty of Health Sciences.

This study has not been submitted to any other journal for consideration for publication, nor has it been published in any other form other than the dissertation submission mentioned above.

A.3 Highlights

- We analyse the utility of blood cultures in the Emergency Centre
- Blood cultures are prone to high rates of contamination
- Blood cultures demonstrate little utility in the subsequent management of patient illness
- Further training is needed to reduce contamination rates of blood cultures

A.4 African Relevance

- South Africa has a unique burden of infectious disease
- Resource limitations may increase the risk for contamination
- Protocols and training need to be relevant to the local disease profile

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Please ensure that every reference cited in the text is also present in the reference list (and vice versa). Any references cited in the abstract must be given in full. Unpublished results and personal communications are not recommended in the reference list, but may be mentioned in the text. If these references are included in the reference list they should follow the standard reference style of the journal and should include a substitution of the publication date with either "Unpublished results" or "Personal communication" Citation of a reference as "in press" implies that the item has been accepted for publication.

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As a minimum, the full URL should be given and the date when the reference was last accessed. Any further information, if known (DOI, author names, dates, reference to a

source publication, etc.), should also be given. Web references can be listed separately (e.g., after the reference list) under a different heading if desired, or can be included in the reference list.

References in a special issue

Please ensure that the words 'this issue' are added to any references in the list (and any citations in the text) to other articles in the same Special Issue.

Reference style

Text: Indicate references by superscript numbers in the text. The actual authors can be referred to, but the reference number(s) must always be given.

List: Number the references in the list in the order in which they appear in the text.

Examples:

Reference to a journal publication:

1. Van der Geer J, Hanraads JAJ, Lupton RA. The art of writing a scientific article. *J Sci Commun*

2000;**163**:51–9. Reference to a book:

2. Strunk Jr W, White EB. *The elements of style*. 3rd ed. New York: Macmillan; 1979. Reference to a chapter in an edited book:

3. Mettam GR, Adams LB. How to prepare an electronic version of your article. In: Jones BS, Smith

RZ, editors. *Introduction to the electronic age*, New York: E-Publishing Inc; 1999, p. 281–304.

Note shortened form for last page number. e.g., 51–9, and that for more than 6 authors the first 6 should be listed followed by "et al." For further details you are referred to "Uniform Requirements for Manuscripts submitted to Biomedical Journals" (J Am Med Assoc 1997;**277**:927–934) (see also http://www.nlm.nih.gov/bsd/uniform_requirements.html).

Journal abbreviations source

Journal names should be abbreviated according to

Index Medicus journal abbreviations: <http://www.nlm.nih.gov/tsd/serials/lji.html>; List of title word abbreviations: <http://www.issn.org/2-22661-LTWA-online.php>; CAS (Chemical Abstracts Service): <http://www.cas.org/sent.html>.

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D.2 Questionnaire

OBTAINING BLOOD CULTURES FROM PATIENTS IN THE EMERGENCY CENTRE

This questionnaire forms part of a study to determine the relevance and value of performing routine blood cultures in the Emergency Centre.

Please answer every question as truthfully and as accurately as possible.

There is a blank space for comments at the end of the questionnaire.

No personal details will be obtained or used in the processing of this questionnaire.

Thank you for your time and cooperation in filling in this questionnaire. Results will be made available to the Emergency Centre at the conclusion of this study.

Should you have any queries regarding the questionnaire or study, please direct them to Dr J Fleming at the contact details below.

For the attention of:

Dr J B Fleming

Po Box 44940

Claremont

7735

jbfleming@imagnet.co.za

+27 82 324 0624

PLEASE CIRCLE YOUR ANSWER – ADDITIONAL COMMENTS CAN BE WRITTEN ON THE BACK

1. What is your position in the Emergency Centre?

Intern COSMO SMO PMO Other: _____

2. Do you regularly perform Blood Cultures on patients you examine in the EC?

Yes No

3. Are you aware of any protocols directing which patients should receive Blood Cultures in the EC?

Yes No

4. Have you been trained in the correct procedure to take Blood Cultures?

Yes No

5. Have you ever taken a Blood Culture from a cannula site after insertion?

Yes No

6. Have you ever taken a Blood Culture from the same site as routine admission bloods (e.g. FBC, U&E, Blood Gas etc)?

Yes No

7. Do you use alcohol swabs or liquid antiseptic on the skin before taking a Blood Culture?

Alcohol Swab

Liquid Antiseptic

8. Do you use separate needles for taking the blood sample and for transferring blood from the syringe to the Blood Culture bottles?

Yes

No

9. Do you take Blood Cultures on febrile patients who you are likely to discharge later in the shift?

Yes

No

10. Are you aware of the differences between the Anaerobic and Aerobic Blood Culture Bottles and when to use them?

Yes


No

D.3 Data Collection Tool

Patient Information List

| | |
|------------------------|--|
| File Number | |
| Name | |
| Date of Culture | |
| Date of Result | |
| Aerobic/Anaerobic/Both | |
| Culture Result | |
| Date of Discharge | |
| Initial Therapy | |
| Change in Therapy | |
| EC Diagnosis | |
| Ward Diagnosis | |
| Other | |

D.4 Ethics Approval

| | |
|---|--------------------------------|
|  | UNIVERSITY OF CAPE TOWN |
| <div>Health Sciences Faculty Research Ethics Committee Room F57/54 Groote Schuur Hospital Old Main Building Observatory 7925 Telephone: (021) 650 6134 • Facsimile: (021) 650 5411 e-mail: comr@uct.ac.za</div> | |
| 19 August 2009 | |
| REC REF: 327/2009 | |
| Dr J Pienning Emergency Medicine | |
| Dear Dr Pienning | |
| PROJECT TITLE: DO ROUTINE BLOOD CULTURES IN THE EMERGENCY CENTRE ALTER PATIENT MANAGEMENT | |
| Thank you for submitting your study to the Research Ethics Committee for review. | |
| It is a pleasure to inform you that the Research Committee has formally approved the above mentioned study. | |
| Approval is granted for one year till the 31 st August 2010. | |
| Please submit an annual progress report if the research continues beyond the expiry date. Please submit a brief summary of findings if you complete the study within the approved period so that we can close our file. | |
| Please note that the ongoing ethical conduct of the study remains the responsibility of the principal investigator. | |
| Please quote the REC REF in all your correspondence. | |
| Yours sincerely | |
| PROFESSOR M BLOCKMAN CHAIRPERSON, HSE HUMAN ETHICS | |
| Fiscal Wide Area Identifier Number: FWA0001601 Institutional Review Board (IRB) number: IRB00000006 | |
| cc: email | |